GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

January 1987

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A chemistry data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example	**Answer Sheet**
This examination is for the subject area of	A B C D
A. Chemistry	● ② ③ ④
B. Biology	
C. Physics	
D. Mathematics	

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1987

PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B.

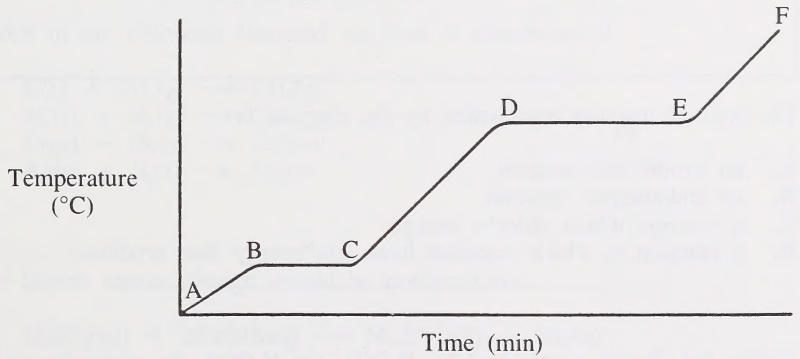
DO NOT TURN THE PAGES TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

1. If energy is added to a substance and it does not result in a rise in temperature, the inference is that the substance may be changing

A. from a gas to a solid
B. from a liquid to a gas
C. from a gas to a liquid
D. in amount of kinetic energy

Use the following information to answer question 2.

A solid sample was heated uniformly for a period of time and the following graph was obtained by using the data collected.

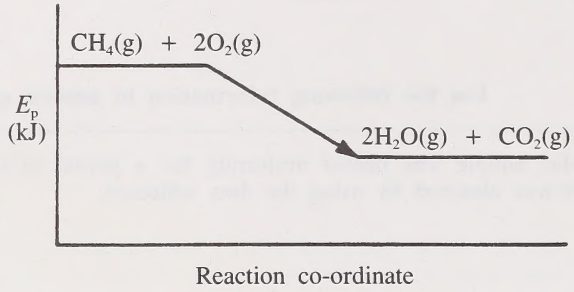


2. The section of the graph from C to D could best be interpreted as a gain in

A. kinetic energy and potential energy
B. potential energy and a phase change
C. kinetic energy and a temperature change
D. potential energy and a temperature change

Use the following information to answer question 3.

The diagram below represents the change in potential energy for the combustion of methane.



3. The type of reaction represented by the diagram is

A. an exothermic reaction
B. an endothermic reaction
C. a reaction which absorbs energy
D. a reaction in which reactants have less energy than products

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4. During the change represented by $H_2O(l) \longrightarrow H_2O(g)$, the molecules undergo

A. an increase in kinetic energy
B. a decrease in potential energy
C. an increase in potential energy
D. a decrease in both kinetic and potential energies

5. Given the equation $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \longrightarrow HCl(g) + 92.6$ kJ, ΔH per mole of chlorine gas is

A. +185.2 kJ/mol
B. +92.6 kJ/mol
C. −92.6 kJ/mol
D. −185.2 kJ/mol

6. The species which has a standard enthalpy of formation defined to be zero is

A. $CO(g)$
B. $Co(s)$
C. $CaO(s)$
D. $CO_2(g)$

7. Which of the following is an endothermic process?

A. Evaporation of gasoline
B. Methane reacting with oxygen
C. Sulphuric acid added to water
D. Hydrogen reacting with oxygen

8. Which of the following chemical reactions is endothermic?

A. $C(s) + 2H_2(g) \longrightarrow CH_4(g)$
B. $2C(s) + H_2(g) \longrightarrow C_2H_2(g)$
C. $Cu(s) + \frac{1}{8}S_8(s) \longrightarrow CuS(s)$
D. $Ag(s) + \frac{1}{2}I_2(s) \longrightarrow AgI(s)$

9. The largest energy change should be predicted for

A. $H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$

B. $C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(g)$

C. $C_{25}H_{52}(l) \longrightarrow C_{25}H_{52}(g)$

D. ${}^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He$

10. When propane is burned to produce gaseous products, the molar heat of combustion is

A. -3218.7 kJ/mol
B. -3011.1 kJ/mol
C. -2220.3 kJ/mol
D. -2043.9 kJ/mol

Use the following information to answer question 11.

ΔH_f for FeO(s)	=	-268 kJ/mol
ΔH_f for Fe_2O_3(s)	=	-823 kJ/mol

11. The heat of reaction for $2FeO(s) + \frac{1}{2}O_2(g) \longrightarrow Fe_2O_3(s)$ is

A. -1359 kJ
B. -1091 kJ
C. -555 kJ
D. -287 kJ

Use the following information to answer question 12.

Experimental data were used to calculate a value of -1406.9 kJ as the heat of reaction for

$$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(l)$$

12. Using the calculated value, the heat of formation per mole of $C_2H_4(g)$ is

A. 5.23 kJ/mol
B. 48.1 kJ/mol
C. 136.3 kJ/mol
D. 1358.8 kJ/mol

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13. 4.19 J is the amount of heat required to raise the temperature of

A. 1 g of water through 1°C
B. 1 mol of water through 1°C
C. 1 g of substance through 1°C
D. 1 mol of substance through 1°C

14. Which set of materials could best be used to determine the specific heat of $H_2O(l)$?

A. Balance, thermometer, calorimeter, water, ice
B. Voltmeter, thermometer, calorimeter, water, ice
C. Balance, thermometer, calorimeter, water, stirring rod
D. Balance, thermometer, calorimeter, water, bunsen burner

Use the following information to answer question 15.

I. $N_2(g) + 2O_2(g) \longrightarrow 2NO_2(g)$	$\Delta H = 67.6$ kJ
II. $N_2(g) + O_2(g) \longrightarrow 2NO(g)$	$\Delta H = 180.8$ kJ

15. To determine ΔH for the reaction $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$, the correct procedure would be to

A. add the reverse of both I and II
B. reverse I and add to II
C. reverse II and add to I
D. add I and II

Use the following information to answer question 16.

$SiO_2(s) + CO_2(g) + 1141 \text{ kJ} \longrightarrow SiC(s) + 2O_2(g)$

$C(s) + O_2(g) \longrightarrow CO_2(g) + 393.5 \text{ kJ}$

$Si(s) + O_2(g) \longrightarrow SiO_2(s) \qquad \Delta H = -859.4 \text{ kJ}$

16. When the given data are used, the predicted ΔH_f for SiC(s) is

A. -2394 kJ/mol
B. -112 kJ/mol
C. $+1607$ kJ/mol
D. $+2394$ kJ/mol

Use the following information to answer question 17.

$C_2H_6(g) + \frac{7}{2}O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(g) \qquad \Delta H = -1428.5 \text{ kJ}$

17. The amount of energy released per mole of oxygen consumed is

A. 1.43×10^2 kJ
B. 2.04×10^2 kJ
C. 4.08×10^2 kJ
D. 5.00×10^3 kJ

Use the following information to answer question 18.

$$SO_2(g) + \tfrac{1}{2}O(g) \longrightarrow SO_3(g) \qquad \Delta H = -96.4 \text{ kJ}$$

18. If 200 g of $SO_3(g)$ were produced, then the amount of energy released should be

A. 301 kJ
B. 241 kJ
C. 151 kJ
D. 38.6 kJ

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19. A property that would indicate a lemon is acidic is that it

A. tastes sour
B. tastes bitter
C. dissolves grease
D. turns a starch solution blue

20. The reaction of an acid with a base is classified as

A. equilibrium
B. dissociation
C. transformation
D. neutralization

21. According to the Arrhenius theory, a base is defined as a species that dissociates in water to

A. decrease both $[H^+(aq)]$ and $[OH^-(aq)]$
B. increase both $[H^+(aq)]$ and $[OH^-(aq)]$
C. decrease hydroxide ion concentration
D. increase hydroxide ion concentration

Use the following information to answer question 22.

Four unknown solutions W, X, Y, and Z were placed into separate beakers containing distilled water. The following observations were made.

Substance W – the temperature of the water increased
Substance X – the conductivity of the water increased
Substance Y – the pH of the water increased
Substance Z – the rate of corrosion of Fe(s) placed in the water increased

22. The substance which is NOT likely an acid is

A. W
B. X
C. Y
D. Z

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23. A water solution of potassium chloride would

A. have no effect on the color of litmus
B. turn blue litmus red
C. turn red litmus blue
D. be acidic

24. For the reaction $NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$, water acts as

A. a proton donor
B. a Brønsted base
C. an Arrhenius acid
D. an Arrhenius base

25. The solution that would have the least pH is a 0.10 mol/L solution of

A. boric acid
B. acetic acid
C. oxalic acid
D. hydrosulphuric acid

26. When the acid HCN(g) is mixed with water, the correct statement is that

A. the reaction will favor products
B. $CN^-(aq)$ is a weaker base than $H_2O(l)$
C. the HCN(g) dissociates almost completely
D. the acid that forms is a stronger acid than HCN(g)

27. When equal volumes of 0.10 mol/L HBr(aq) and 0.10 mol/L $C_6H_5COOH(aq)$ are compared, the $C_6H_5COOH(aq)$ solution should be predicted to

A. have a higher pH value
B. have a higher hydronium ion concentration
C. produce a greater volume of $H_2(g)$ when reacted with zinc
D. require a smaller volume of 0.10 mol/L KOH(aq) for neutralization

28. A student mixes a 0.30 L sample of 0.020 mol/L hydrochloric acid with enough water to make 5.0 L of solution. The pH of this new solution should be predicted to be

A. 11.08
B. 2.92
C. 2.22
D. 1.70

29. A student titrates 0.5 mol/L HCl(aq) with NaOH(aq). The resulting solution should be predicted to show

A. increased $[H_3O^+(aq)]$
B. decreased $[OH^-(aq)]$
C. decreased pH
D. increased pH

30. A student should predict the $[OH^-(aq)]$ in a solution with a pH of 12.40 to be

A. 4.0×10^{-13} mol/L
B. 2.5×10^{-12} mol/L
C. 4.0×10^{-3} mol/L
D. 2.5×10^{-2} mol/L

31. The best indicator for determining the pH of 0.001 mol/L NaOH(aq) is

A. alizarin yellow R
B. indigo carmine
C. methyl violet
D. thymol blue

32. The net ionic equation which best describes the reaction of aqueous methanoic acid with aqueous potassium hydroxide is

A. $HCOOH(aq) + K^+(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + K^+(aq) + HCOO^-(aq)$

B. $H_3O^+(aq) + HCOO^-(aq) + OH^-(aq) \rightleftharpoons 2H_2O(l) + HCOO^-(aq)$

C. $HCOOH(aq) + KOH(aq) \rightleftharpoons H_2O(l) + HCOOK(aq)$

D. $HCOOH(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + HCOO^-(aq)$

33. A 0.40 mol/L acid that is 10% dissociated will have a pH of

A. 1.40
B. 0.60
C. 0.40
D. 0.040

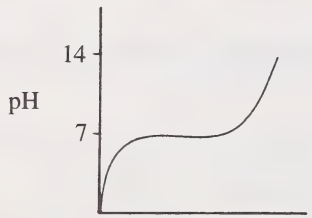
34. The chemical species which would be predicted to react and favor products at equilibrium are

A. $NH_4^+(aq)$ and $HS^-(aq)$
B. $H_2S(aq)$ and $HCO_3^-(aq)$
C. $CH_3COOH(aq)$ and $HS^-(aq)$
D. $H_3BO_3(aq)$ and $CH_3COO^-(aq)$

Use the following information to answer question 35.

Students titrated KOH(aq) with HBr(aq) and used the collected class data to produce a graph which would represent the titration.

W



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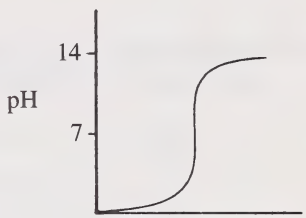
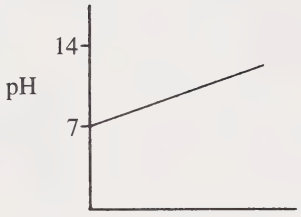


Y



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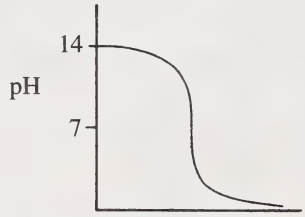

35. The best graphic representation for the titration is

A. W
B. X
C. Y
D. Z

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36. Students titrated a strong monoprotic acid to the end point with 1.00×10^{-2} mol/L NaOH(aq). 47.0 mL of the NaOH were required for 25.0 mL of acid. What is the calculated $[H_3O^+(aq)]$ of the initial acid solution?

A. 8.50×10^{-6} mol/L
B. 5.32×10^{-3} mol/L
C. 1.88×10^{-2} mol/L
D. 5.39×10^{1} mol/L

37. When 60.0 mL of 0.20 mol/L $HNO_3(aq)$ are mixed with 40.0 mL of 0.20 mol/L KOH(aq), the resulting $[H_3O^+(aq)]$ is

A. 0.040 mol/L
B. 0.060 mol/L
C. 0.080 mol/L
D. 0.12 mol/L

38. For a redox reaction represented by $M + N \longrightarrow P + Q$, the correct statement is

A. if M is oxidized, N gains electrons
B. if M loses electrons, N is oxidized
C. if M is reduced, N is the oxidizing agent
D. if M is the reducing agent, N is oxidized

39. The chlorate ion (ClO_3^-) is reduced in an acidic solution to form the chloride ion (Cl^-). The balanced half-reaction is

A. $ClO_3^-(aq) \longrightarrow Cl^-(aq) + \frac{3}{2}O_2(g)$

B. $ClO_3^-(aq) + 6H^+(aq) \longrightarrow Cl^-(aq) + 3H_2O(l)$

C. $6H^+(aq) + ClO_3^-(aq) + 6e^- \longrightarrow Cl^-(aq) + 3H_2O(l)$

D. $3H^+(aq) + ClO_3^-(aq) + 3e^- \longrightarrow Cl^-(aq) + 3H_2O(l)$

40. For the reaction $Cr^{2+}(aq) + Fe^{3+}(aq) \longrightarrow Cr^{3+}(aq) + Fe^{2+}(aq)$, the substance being reduced is

A. $Cr^{2+}(aq)$
B. $Fe^{2+}(aq)$
C. $Cr^{3+}(aq)$
D. $Fe^{3+}(aq)$

41. The substance that can act as an oxidizing and reducing agent should be predicted to be

A. Ba(s)
B. $Sn^{2+}(aq)$
C. $Hg^{2+}(aq)$
D. $Fe^{3+}(aq)$

Use the following information to answer question 42.

Students recorded the following observations while testing the reaction of various metals and their ionic solutions.

Metal Ion	$W^+(aq)$	$X^+(aq)$	$Y^+(aq)$	$Z^+(aq)$
W(s)	NR	✓	✓	NR
X(s)	NR	NR	NR	NR
Y(s)	NR	✓	NR	NR
Z(s)	✓	✓	✓	NR

✓ = reaction

NR = no reaction

42. The strongest reducing agent should be interpreted to be

A. $X^+(aq)$
B. X(s)
C. $Z^+(aq)$
D. Z(s)

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43. A redox reaction occurs between aqueous solutions of NaI and $NaAuCl_4$. The correct net ionic equation for this reaction is

A. $AuCl_4^-(aq) + 2I^-(aq) \longrightarrow Au(s) + 4Cl^-(aq) + I_2(s)$

B. $2AuCl_4^-(aq) + 6I^-(aq) \longrightarrow 2Au(s) + 8Cl^-(aq) + 3I_2(s)$

C. $2NaAuCl_4(aq) + 6NaI(aq) \longrightarrow 2Au(s) + 8NaCl(aq) + 3I_2(s)$

D. $2NaAuCl_4(aq) + 6NaI(aq) \longrightarrow 8Cl^-(aq) + 8Na^+(aq) + 3I_2(s)$

44. A student should predict that for the reaction represented by $4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(s)$,

A. metallic iron is reduced to Fe^{3+} ions
B. metallic iron is oxidized to Fe^{3+} ions
C. gaseous oxygen is oxidized to O^{2-} ions
D. both metallic iron and gaseous oxygen are reduced

45. The oxidation number for Cl in Cl_2 is

A. +2
B. +1
C. 0
D. −1

46. The substance in which the oxidation number of chlorine is +5 is

A. ClO_2
B. $HClO_2$
C. $HClO_3$
D. $HClO_4$

Use the following information to answer question 47.

$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(l)$	$E^\circ = +0.68$ V

47. In a titration experiment 25 mL of a solution of 0.002 mol/L $H_2O_2(aq)$ were used to reduce 100 mL of $Fe^{3+}(aq)$ solution to $Fe^{2+}(aq)$. The calculated concentration of $Fe^{3+}(aq)$ should be

A. 0.006 mol/L
B. 0.004 mol/L
C. 0.002 mol/L
D. 0.001 mol/L

---

48. If a student selected the Ag/Ag^+ half-cell as the standard for the reduction potential series and assigned an E° value of zero, then the assigned potential for the Sn/Sn^{2+} half-cell would be

A. −0.94 V
B. −0.80 V
C. +0.14 V
D. +0.66 V

Use the following information to answer question 49.

By using a standard half-cell with various substances, students collected data and arranged them in the following form.

1. $Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$	$E^\circ = +2.37$ V
2. $Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$	$E^\circ = +0.41$ V
3. $Ag(s) \longrightarrow Ag^{+}(aq) + e^-$	$E^\circ = -0.80$ V
4. $2Cl^-(aq) \longrightarrow Cl_2(aq) + 2e^-$	$E^\circ = -1.36$ V

49. The students should predict that the greatest voltage would be provided by constructing a cell that uses half-reactions

A. 1 and 3
B. 1 and 4
C. 2 and 3
D. 2 and 4

---

50. The calculated E° value for the reaction
$2Al(s) + 3I_2(aq) \longrightarrow 2Al^{3+}(aq) + 6I^-(aq)$ is

A. +2.20 V
B. +1.12 V
C. −1.12 V
D. −2.20 V

51. The net potential of a redox reaction is the

A. sum of the two reduction potentials
B. sum of the two oxidation potentials
C. sum of the reduction and oxidation potentials
D. difference between the reduction and oxidation potentials

52. A student dropped pellets of nickel into a solution that contained $Zn^{2+}(aq)$, $Fe^{2+}(aq)$, $Pb^{2+}(aq)$, and $Cd^{2+}(aq)$ ions and predicted the products that would form. These products should be $Ni^{2+}(aq)$ and

A. Cd(s)
B. Fe(s)
C. Pb(s)
D. Zn(s)

53. Which statement describes an electrochemical (Voltaic) cell?

A. Potential energy is converted to electrical energy.
B. Electrical energy is converted to chemical energy.
C. Electrical energy is converted to kinetic energy.
D. Kinetic energy is converted to chemical energy.

54. The predicted net potential of a zinc-dichromate (acidified) electrochemical cell should be

A. +0.57 V
B. +1.14 V
C. +2.09 V
D. +3.61 V

55. The FALSE statement concerning electrolysis is that

A. the reaction is non-spontaneous
B. electrolysis consumes electrical energy
C. positive ions migrate when electrolysis occurs
D. the electrolyte provides a path for the electrons

56. If a student uses a current of 5.00 A for 2.00 h to electrolyse AgBr(l), what mass of Ag(s) should be predicted to be deposited at the cathode?

A. 80.6 g
B. 40.2 g
C. 20.1 g
D. 10.8 g

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

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Use the following information to answer question 1.

The following materials were made available to students for use in an experiment.

10.0 g dry NaOH(s) pellets
100 mL $H_2O(l)$ (slightly below room temperature)
calorimeter
thermometer

(5 marks)

1. Describe a procedure that could be used to determine the molar heat of solution for NaOH(s).

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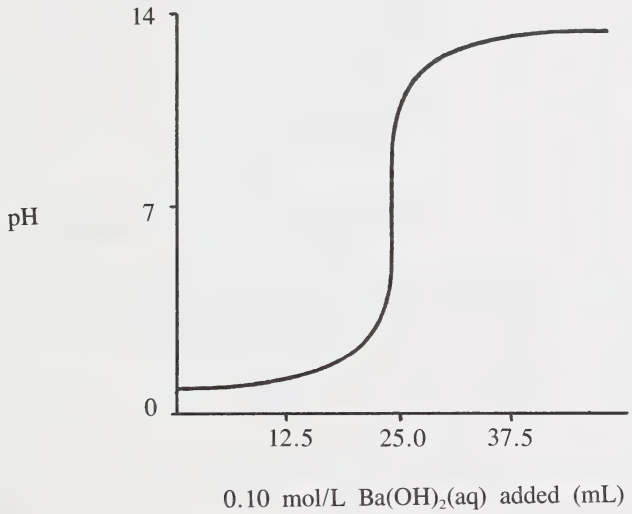
Use the following information to answer question 2.

A student titrated 45.0 mL of a nitric acid solution of unknown concentration with a 0.10 mol/L barium hydroxide solution. A pH meter was used to obtain the following titration curve:



2. a. Based on the results shown on the graph, calculate the concentration of the nitric acid solution. **(4 marks)**

b. What would be the best indicator for this titration?

_____

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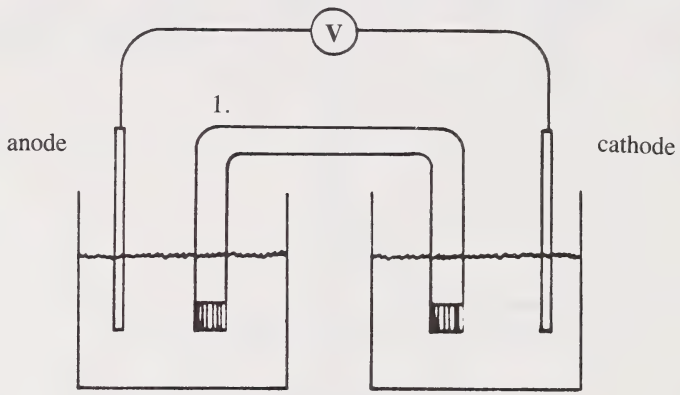
Use the following information to answer question 3.

An electrochemical cell was constructed as follows. A zinc strip of known mass was immersed in a beaker of 1.0 mol/L $ZnSO_4(aq)$. A silver strip of known mass was immersed in a second beaker containing 1.0 mol/L $AgNO_3(aq)$. The metal strips were then connected by a wire and the beakers connected by a salt bridge. After several hours the mass of the Zn electrode was found to have decreased.



(5 marks)

3. a. The part of the diagram labelled 1. is called a

_____

b. The material that should be used for the anode is

_____

c. The direction of the electron flow would be from

_____ to _____

d. The net ionic equation for the reaction that should occur would be

_____

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e. Calculate the E°_{net} for the cell.

f. If the mass of the zinc electrode changes by 2.6 g, calculate the change in mass of the silver electrode.

g. Does the silver electrode gain mass or lose mass?

_____

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT SHEET

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION

TEAR-OUT SHEET

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M1 M2 M3 M4

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CHEMISTRY 30

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